1 Introduction

The project aims at providing information on the *possibilities of reinforcing and integrating existing climate, resource and waste policy through a product policy.*

Attention is shifting more towards examining the potential of policies oriented at products and consumption patterns, because the sector-based, mostly 'process'-oriented environmental policies seem insufficient to reach the objectives of sustainable development. The Integrated Product Policy (IPP) at the European level[1] and the preparation of the "Federal Guiding Plan on Product Policy and Environment" (2001) in Belgium were the general policy framework for the presented project.

The perspective of "Integrated" in integrated product policy is the consideration of the entire product's life cycle chain and the consideration of multiple environmental problems to avoid averse effects and shifting to other impact types.

1. Phase 1 of this project is on the *evaluation of lifecycle impacts of products in Belgium*. This identification should allow policy makers to select products that qualify for an assessment of their improvement potential and, depending on the outcome, for being addressed by product policy (at Belgian federal level or at the European IPP level).[2] This work was carried out during the first year of the project (2002).

2. Secondly, we focused on 4 case-studies : household packaging, computers and related paper use, passenger cars and domestic dwelling. This focus was separated in two phases :

   a. Phase 2 of this project contributes on the methodological framework for the *evaluation of theoretical impact reductions* due to product policy measures. This work was carried out in 2003.

   b. Besides these environmental analysis, phase 3 of the project wants to contribute to establish a framework for the *evaluation of proposed product policy measures by stakeholders*. Stakeholders were able to evaluate a set of possible measures for the considered product case studies on these criteria. This work was carried out in 2004.

2 Phase 1 : evaluation of lifecycle impacts of products in Belgium

2.1 Goal and scope of this phase

2.1.1 General methodological framework

The objectives of this phase were translated into a specific goal and scope description at a more detailed level. The choices are as follows:

a) The study focused on identifying the product groupings on the basis of their current life cycle environmental impacts. They were identified on the basis of the environmental impacts of the whole volume of products purchased by households in Belgium, for the reference year 2000.

[1] COM(2003) 302 final

[2] This study hence does not seek to identify products or product groups for which *implementation of improvement options* is relatively easy. The aim is to identify the 'hot spots' with regard to environmental pressure, rather than to identify the 'low hanging fruits'.

b) The study primarily focused on the final consumption in Belgium, both produced in Belgium and produced abroad; not on production for export.

c) This study is limited to impact categories on resources, waste and climate change.

2.1.2 Definition of environmental indicators

These data were mostly extracted from the database SIMAPRO.

1. Climate Change

Emissions of greenhouse gases (CO_2, CH_4, N_2O, F-gases) can be transformed into global warming potentials expressed in CO_2-equivalents. This aggregation method which is also in accordance with the UNFCCC (2000) guidelines is based on the use of a set of conversion factors.

2. Waste

According to the Directive 75/442/EEC waste means "any substance or object in the categories set out in its Annex I which the holder discards or intends or is required to discard". In that sense, all three stages of a product's life represent sources of waste. For generated waste, comparable operational cause-effect models have not been developed yet for use in LCA studies. In so far, the pressure of waste generation as such (total tons) is taken as an impact potential.

3. Resource use

Environmental impacts resulting from the use of raw materials occur at the different stages of the raw materials life cycle : mining, processing, disposal. The associated impacts resulting from the use of these materials in product life cycles are reflected in the other impact indicators on greenhouse gas emissions, energy use, raw materials use, waste etc. The resource indicators mentioned below reflect the demand of resources due to product consumption:

1. Material intensity indicators (M) : covers the total amount of basic materials used for the manufacturing and use of products, often reflecting the weight of the product and the weight of the materials lost during processing (i.e. amount of steel, plastic, glass etc.)

2. Energy intensity indicators (E) : covers the total amount of primary energy used for the manufacturing and use of products. All energy carriers are traced back to calculate their primary energy equivalents.

3. Raw material use indicators (R): covers the weight of all traced back primary raw materials that have to be extracted from the ecosphere to generate and use the product.

For the raw materials (R), the definitions of resources provided by the EC (COM 527, 2003) are adopted. According to the Communication, natural resources cover raw materials, environmental media, resource flows and space. In the present study we consider only raw materials and energy.

2.2 Summary of results

The following table shows the contribution of the most important function classes to the different impact indicators on resource use, waste and greenhouse gases.

Function class	Inputs			Outputs	
	Energy	Intermediate material	Raw materials	emissions to air GHG	waste
BUILDING STRUCTURE	6.3%	78.8%	61.9%	10.8%	79.5%
BUILDING OCCUPANCY	38.2%	0.4%	0.9%	33.7%	0.2%
FURNITURE FOR INTERIOR	0.4%	1.0%	1.0%	0.8%	1.1%
ELECTRICAL APPLIANCES	9.8%	0.9%	2.6%	5.6%	0.7%
HEALTHCARE AND DETERGENTS	1.0%	1.3%	0.5%	0.3%	0.7%
TRANSPORT	33.7%	3.2%	15.1%	36.4%	3.2%
LEISURES	1.7%	0.2%	1.1%	1.0%	0.2%
INFORMATION TECHNOLOGIES AND PAPER	3.4%	4.9%	4.8%	3.4%	4.5%
GARDEN	0.3%	0.1%	0.4%	0.2%	0.1%
PACKAGING	4.7%	8.7%	11.5%	6.6%	9.3%
TEXTILE	0.6%	0.4%	0.3%	1.2%	0.4%

	30%
15%	*30%*
5%	*15%*

Table 1 . Impacts from the most important function classes

We can conclude the following on the importance of the function classes:

- 'Building Structure', 'Building Occupancy' and 'Transport' are very important from an overall waste, resources and GHG point of view.

- 'Packaging' is important as an intermediate group, but should be divided over and related to their final product categories.

Most other function classes do contribute significantly, or only to a limited number of impacts:

- Information technologies and paper are important with regard to material use and use of scarce resources.

- Electrical appliances are relevant for energy use, certainly when taking all the original products into account and also with regard to water use.

When comparing these results with other similar studies, general agreement exists on these highest contributors, however differences exist about their mutual ranking.

The following product categories always show up in the top ranking of the different studies:

- Transport: passenger cars and transport of goods (last only considered by Labouze et al. (2003))
- Food production (not considered in this study, but considered in all other studies)
- Heating
- Construction: housing, offices and civil work (last two only considered by Labouze et al. (2003))

No agreement has been found on the 'midrange' categories following these top rankers and the results from the different studies are not conclusive.

3 Detailed analysis of four case-studies

3.1 Phase 2 : methodology for the calculation of the theoretical improvement potentials

3.1.1 General framework

In the framework of the project, we have developed an analytical tool that aims at linking product life cycle stages with the emissions, emission reduction potentials and relevant policies and measures.

This analytical tool is presented in

Table 2. It summarises how different improvement strategies of products can influence their greenhouse gases emissions at different life cycle stages. Vertically are listed the different improvement strategies that can be envisaged to reduce impacts. Horizontally, the product life cycle stages are distinguished. The coloured boxes represent the life cycle stages for which the impacts could be potentially affected by the strategy. The colour shows to what extent the strategy is actually envisaged in current environmental programmes (especially for Belgium). Measures envisaged in these programmes can target one or more strategies.

improvement strategies	part of life cycle in which the impacts could be reduced						
	material processing	paroduct manufacturing	production waste treatment	distribution	product use	product waste treatment	level of implementation
Changes in final demand for the function	■	■	■	■	■	■	low
Substitution of products fulfilling the same function	■	■	■		■	■	medium
Product reuse	■	■	■			■	medium
Optimising the product's lifespan	■	■	■	■	■	■	medium
Rational use of the product					■		medium
Changing the product composition	■	■	■			■	low
Increasing end-of life recycling	■	■	■			■	medium
Industry process substitution	■	■	■				medium
Improving the efficiency of energy transformation	■	■					high
Energy substitution	■	■					high
Improving the efficiency of materials	■	■	■			■	low
Energy recovery	■	■	■			■	high
Reducing transport distances for materials and products				■			low

Table 2 : Improvement strategies and product life cycle stages

For all four product groups studied in the project, we have developed a common methodology for the construction of scenarios. Our main concerns, were to 1) reflect the annual environmental impacts from the existing and from the new products used in Belgium until 2010, with a clear distinction between impacts from the disposal phase of existing products, from the use phase of existing products and from the production phase of new products; and to 2) quantify the individual impacts from each general improvement strategy as well as the impacts from the combination of all these general improvement strategies.

It starts with a "business as usual" scenario (BAU) that reflects an evolution where the current policy trends will not change in the future. This scenario is based on the different data sets and on several assumptions regarding future trends. Then alternative scenarios are built in order to reflect the relevant improvement strategies. This was done by changing the parameter(s) reflecting the effect of the strategy.

3.1.2 Methodological differences with phase 1

A product oriented policy would potentially aim at curbing not only impacts from products bought each year, but also impacts from products already used in the country (existing stock). This means that both the existing stock of products and the products put on the market must be considered in the study, Considering both stock and new products adds some data requirement as compared to the previous phase of the project where only new products put on the market were analyzed.

During the first phase of this study, the waste was calculated by weight units (kilograms). During the second phase, we focused on the one hand on the environmental impacts which are generated by waste treatment, and on the other hand on the amount of final waste (which goes to landfills).

In this phase of the project, the allocation rule which was applied was the 50% / 50% rule (50% of impacts allocated to production, 50% to waste treatment).

As the present study aims at evaluating to which extent a product policy would contribute to the simultaneous fulfillment of the three objectives to reduce GHG emissions, waste and pressure on raw materials, impacts and impact reductions have been calculated in such a way as to fit with existing environmental objectives. As a result, for GHG emissions and for waste, annual emissions need to be estimated and especially "domestic" emissions.

For the production phase it was not possible to isolate the share of impacts occurring in Belgium (except for the most representative building materials) nor for the use phase for spare parts and consumables. For energy use during the use and disposal phase, the estimation was made for each specific product.

3.2 Phase 3 : methodology for the evaluation of policies and measures

3.2.1 Introduction

Once the impacts of the four case studies were determined, we envisaged how a product policy could help in lowering these impacts. We thus reviewed other studies on these products in order to draw a first list of possible additional measures aiming at reducing the impacts in terms of GHG emissions, resource use or waste production.

The objective of this new task was to develop realistic strategies. It was not possible, however, to estimate, as a result of this, realistic emission reduction potentials. Indeed, given the limited usability of the first results, we decided to concentrate on consolidating them.

In order to identify measures and quantify variables, the expertise of stakeholders was required. Indeed, ex ante and ex post evaluations of measures are scarce and are not sufficient to draw conclusions.

We reviewed a series of recognized methods based on pragmatic criteria and from this designed our own methodology, based on the Delphi method. This method is based on an anonymous consultation of experts / stakeholders and is carried out in several « rounds ». Feedback on the previous results is given at each round, in order for stakeholders to react on these results. Here we used it to test some propositions for measures.

3.2.2 Development of the methodology

The set of measures needed to be evaluated for their realistic impact reduction potential. After the first round we wanted to obtain a list of measures that are found to be feasible, efficient and well accepted Therefore, a Delphi questionnaire was supplied to the stakeholders willing to cooperate, asking them to evaluate the measures on a series of criteria (seven different criteria) as well as giving free comments on measures and on objectives.

The questionnaires were filled in through the Internet, on a web site. We had several findings from the first round on the general methodology for this consultation. For the second round we thus reduced the criteria to the following ones: acceptance by users (user perception and user costs); acceptance by industry (costs for industry and social costs); efficiency

However, the results altogether did not enable a common ground required to carry out the identification of priority measures, and the other steps which we intended to carry out (quantification of variables and calculation of realistic improvement potentials). Based on these findings, we decided to reorient the second round. In agreement with the user committee, the second round was dedicated to deepening the comments from all stakeholders, with the aim to present the variety of opinions of the different stakeholders on the subject of product-oriented policies and measures.

3.3 Results of the detailed analysis of the four case-studies

3.3.1 Building structure (housing)

3.3.1.1 Technical potentials and synergies between impacts

According to our results, although CO_2 emissions from the demand for SFH represent less than 10% of heating, these emissions are still significant (more than 2200 kt).

According to the calculation, the four individual strategies (demand change, substitution of products, changing composition and increase of recycling) to reduce all three impacts in the near future seem to represent non negligible improvement potentials. Shifting from new construction to renovation would lead to the highest emission reduction. On the opposite the use of recycled material results in a smaller emission reduction. However the percentage reduction is of course influenced by the underlying assumptions in each scenario. All together, the four modelled strategies could lead to an emission reduction ranging from 33% to 37% as compared to the BAU scenario in 2010.

3.3.1.2 Conclusions from stakeholder consultation

For the housing product category, the need to involve the professionals appears clearly. They should be the main target for labels and calculation tools regarding environmental impacts of the building. It has to be noted that labels should be applied to materials, rather than to the building sector.

A general comment is the need to take into account the whole life cycle of dwellings as the use phase which has not been modelled during this study, is prevalent concerning environmental impacts. Moreover, those environmental impacts should be extended given the fact that only GHG have been modelled.

Stakeholders in general ask for more detailed research on the impacts of renovation vs new buildings. Sociological studies would also be necessary, concerning the motivation of consumers and a focus on low income households.

One particular point for this product category is the need tot take into account technical specifications of materials, their quality sand also their possible consequences on the health.

One proposal from the researchers (IFD buildings) appears as a possible contribution to decreasing environmental impacts of dwellings. This proposal would require further evaluation.

3.3.2 Household packaging (drink and food)

3.3.2.1 Technical potentials and possible synergies

In phase 2 of the project, a characterization on resources depletion was carried out. Comparing to the other product categories, packaging is of marginal relevance. From a waste perspective, many policies focussed at recycling and prevention already exist and the calculated avoided impacts substantial. Also, for food and beverage packaging, a decoupling of impacts vs. consumption trend could be concluded. In conclusion, this study cannot confirm that packaging is a priority product group.

Five individual strategies (product substitution, reuse, material substitution, material recycling, efficient use of materials) to reduce resource depletion, greenhouse gas emissions and ultimate waste resulting from household packaging (food and beverage packaging, representing ¾ of all household packaging brought on the market) have been evaluated as well as a combination of these strategies. The magnitude of these scenario's are cautious to some very ambitious, so do not reflect what is possible in the real world (therefore referred to as "theoretical" potentials).

When combining all strategies, the calculations indicate impact reduction potentials of about 20% for all impacts studied (but should be seen as a theoretical ceiling). Whether they are considered significant depends on the absolute reference impacts: food and beverage represent about 1130 kton GHG-emissions in 2010, 25 kton ultimate waste to landfill and 5 kton Sb-equivalents. Compared to the other studied product categories, this is marginal.

It can be indicated that synergies exist between climate, energy, waste and resource measures and generally have no adverse effects towards other impact categories.

The study on food and beverage packaging also demonstrates that for specific packaging categories, the focus on particular measures can be different: with regard to beverage packaging mainly reuse and reduce strategies are of relevance, with regard to food packaging a focus could be on reduce strategies and the use of bio-based and degradable plastics.

3.3.2.2 Results from stakeholder consultation on policies and measures

The industry is general of opinion that in Belgium, more than 80% of single-use packaging is recycled or reused in a practical way. This category accounts for less than 6% of total waste produced, so packaging has become a non-issue. Also, each item of packaging is the product of a complex balancing act entailing the consideration and weighing up of environmental, economic, social and health-related factors.

Any sort of discrimination based in inadequate or non-existent scientific evidence is rejected and focus should be on changing consumption patterns and doing more with less by means of information and education incentives and voluntary agreements between policy and industry.

Environmental NGO's and policy encourage the implementation of controllable instruments, standards and economic instruments, but many practical obstacles exist i.e. on recycled content, weight reduction (existing Belgian product law and CEN developments). While ecotax on refillable beverage bottles has already been implemented, it's effectiveness cannot be confirmed so far.

3.3.3 Passenger cars

3.3.3.1 Technical potentials and synergies between impacts

An important trend exists for more vehicle kilometres to be driven. In the BAU scenario this trend is expected to hold on until much further than 2010. This trend is a combination of the increasing number of passenger cars in Belgium on the one hand, and the increasing mileage per passenger car on the other. If this trend continues, the GHG emissions (in kton CO_2eq.) would be 30% higher in 2010 compared to 1990. The vast majority (more than 85%) of these life cycle emissions occurs during the use phase of the car; whereas the disposal phase accounts for a mere 0,5%. In the meantime, the raw material use would increase by 25% (mainly fuel use during the use phase; only ¼ during production phase), and waste production by about 10%.

Applying the synthesis scenario could lead to a substantial impact reduction (almost 9% reduction for GHG emissions compared to BAU in 2010). This percentage may seem rather small, but in light of the enormous share of traffic emissions in the worldwide GHG emissions, this reduction represents a very high absolute reduction amount. Yet, in comparison to the 1990 emission levels (which are the basis for the Kyoto protocol), the GHG exhaust would increase by more than 12%.

Several strategies have an opposite influence on the impact categories studied here. This appeals for a standardised computation method for defining the environmental friendliness of a passenger car. Such an attempt is currently being undertaken by U.L.B., V.U.B. and Vito jointly in the project of Ecoscore. These results could mean an important enrichment of the calculations carried out in this project.

3.3.3.2 Conclusions from stakeholder consultation

The reduction of the environmental impact of passenger cars is a fierce challenge for reaching a sustainable traffic system and complying with the agreed norms of the Kyoto protocol. Targeting the demand becomes a very difficult task, that only results in clear improvements on a longer term (before which no change of attitude can be reached). The way to achieve such a mentality shift is expected to be very hard: information alone will not greatly influence a driver's behaviour; more inciting (financially) measures need to be taken in order to produce an effect. Yet, this strategy could certainly make a high contribution to the environmental impact reduction and should therefore not be neglected.

The above remarks on information, fiscal measures and the comparatively small effects on the short term largely apply for the strategy on rational product use as well. This is the second most important strategy on the basis of its effectiveness; it can also yield an important environmental impact reduction (impact computed for only 6 years: 2005-2010).

Next, the optimisation of a car's life span was received with a lot of ambiguity by many respondents concerning the environmental benefit this strategy produces. The changing product composition strategy, which is also subject to two opposite environmental tendencies (namely higher weight and higher plastic production), as well received quite different answers.

3.3.4 Computers and paper

3.3.4.1 Technical potentials and possible synergies

The trend for computers in households is towards increasing impacts up to 2010. This is due to the increasing penetration rates of computers in households. If this trend continues, CO2 emissions should be 47% higher in 2010 than in 2000. It should be noticed that the production phase accounts for about half of these emissions. Raw material use should increase by 26% (mainly due to electricity use in use phase) and waste production by 70%. Applying all above-mentioned strategies (change in final demand, substitution of products, reuse, rational use of product, recycling) could lead to a substantial reduction of these impacts (61% reduction for CO2 emissions compared to BAU in 2010) and to the “zero waste” target by collection and recycling.

For computers and paper in the Federal Public Services, the trend is towards decreasing impacts, due to the shift to laptops and LCD screens, and to the improvement of the efficiency of the paper manufacturing process. But the technical potentials is smaller, there is actually less margin of action than in households. In 2010, the identified technical potential is a reduction of 43% of CO2 emissions (compared to BAU).

There are clear synergies between impacts, i.e. a measure targeting one particular impact is very likely to also positively influence other impacts.

We however would like to emphasise, for this product category, that due to rapid technology changes in the field new products could appear in the near future that could change this picture in a significant manner.

3.3.4.2 Results from stakeholder consultation on policies and measures

For computers, targeting the demand would be a very difficult challenge; this may be possible through the increase of services offering the use of computers, but further research would be needed in this area. The other important issue is the reuse of computers. Indeed, computers are now replaced due to technological evolutions, not to actual breakdown of the equipment. However, for most uses, these computers may still be sufficient. The social economy collect and reuse some of them, however this is not very positively perceived by the industry. There could be room for communication between stakeholders on this area, since the development of reused computers could be very useful in order to decrease their impacts. Concerning energy use in the use phase, the further development of existing labels seem the preferred option for all stakeholders.

For paper, the industry identified the problem of the shortage of used paper on the international market. Promoting the use of recycled paper would thus be difficult to envisage if besides there is no increase of the collection rate of used paper. However, since this collection rate is already high, motivating users would not be an easy task. On the issue of environment-friendly paper, there is an agreement to develop a label based on the EMAS and ISO 14001 certification, while starting negotiations on the international level for EPD-based (environmental product declaration) labels. Ecolabels do not seem an efficient way to sensitise consumers.

3.4 Uncertainties and precautions for interpretation

The life cycle approach of the four case studies imply methodological choices which were explained in details in the previous intermediate report. As any modeling of scenarios, the results obtained are subject to some uncertainty that depends mainly on the level of ambition of the hypothesis that were made. In addition to this ambition level assumed to calculate alternative scenarios, the sources of uncertainties inherent to the analysis must also be taken into account.

The list of possible policies and measures was identified with the aim of decreasing environmental impacts from the four product categories chosen as case studies. The consultation was a first insight in the evaluation of the proposed policies and measures.

It should be noted that while the industry answered widely to this consultation, other actors gave less comments, probably also lacking time and workforce for this task. Moreover, the issues which were dealt with were sometimes very controversial (dealing with packaging for example), and it is clear that some stakeholders answered in the way that best fitted with their own interest.

Thus, we recommend to interpret the results from the consultation as a first opinion mapping of the different stakeholder categories in Belgium on possible product-oriented measures. Further work would be required in order to evaluate precisely possible measures on their socio-economic consequences (including costs/benefits analysis) and the opinion of a larger number of stakeholders should be sought.

Concerning the use of the Delphi method, we would like to underline its advantages and drawbacks. The advantages were the possibility for each stakeholder to speak freely, and the possibility to quantify results. However, we found that the main difficulty came from the understanding of questions from stakeholders. Indeed, because we consulted a wide range of stakeholders (policy, industry, NGO…), questions were perceived differently. As a consequence, the quantitative figures were found to be somewhat uncertain. Moreover, the length of the process prevented some stakeholders to participate (due to a lack of workforce in small structures).

4 Conclusions

This study enabled us to undertake one of the first bottom-up analysis of an economy in Europe (here, the Belgian economy, based on its consumption). This global life cycle evaluation of the impacts of the Belgian consumption in terms of GHG emissions, resource use and waste production was thus limited by data availability problems, as well as necessary methodological choices. However, it allowed us to have an insight on the levels of impacts resulting from the different product groups.

We then analyzed four case studies : computers and paper, housing, cars and household packaging. Though these cases were chosen at the beginning of the project, we see that 2 of them (namely housing and cars) appear as having important impacts. For all four case studies, we identified opportunities for improvement in terms of environmental impacts. Moreover, our research showed clear synergies between GHG emissions, resource use and waste production, therefore showing the opportunities that can derive from measures targeting any of these 3 impacts

Finally, we envisaged a series of measures which could help to reduce the environmental impacts of these four case studies. These measures were submitted to a series of stakeholders in order to evaluate their perceived efficiency and feasibility, as well as acceptance. Though the original aim was to derive from this the calculation of realistic improvement potentials, we perceived the results obtained as not sufficient to establish a solid basis for this calculation. We thus limited our work to a first mapping of the different opinions of the main stakeholders on these measures. This enabled us to find agreements on possible measures, or on the contrary to underline disagreements between stakeholders on some issues. Though the consultation was limited in time and in scope, and though further work would be necessary before drawing clear conclusions, this enabled a first overview of the possibilities for a product policy to contribute to the reduction of the environmental impacts from these four product categories.